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THE ROSE MIDGE.

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INTRODUCTION.

The rose midge, *Dasyneura rhodophaga* (Coq.), an insect related to the Hessian fly, is often the cause of considerable injury to roses grown under glass. In 1912 Davis (3)[1] estimated that the loss due to this pest in two Chicago greenhouses would approximate $10,000 annually. Subsequently this insect was reported by various entomologists as being especially injurious to the flower and leaf buds of the rose, distorting their growth and eventually causing them to turn brown and die.

In the fall of 1916 an infestation was located at Colgate, Md., which, according to the owner, caused an annual loss of from $4,000 to $6,000. Although the house was generally infested, the infestation was limited to the following varieties of roses: Radiance (pink), Hadley (red), Russell (pink), and Killarney (white). The Hadley and Radiance varieties were most severely infested, scarcely a leaf or flower bud escaping attack.

This infestation offered an excellent opportunity for determining a satisfactory means of controlling this pest in a commercial greenhouse, and, in collaboration with Prof. E. N. Cory, entomologist of the Maryland Agricultural Experiment Station, the investigation was begun in October, 1916. Results of these experiments are given on pages 6 and 7.

[1] Figures in parentheses refer to "Literature cited," p. 8.

HISTORY AND DISTRIBUTION.

This rose pest, together with a closely related species, *Diplosis rosivora* Coq., was first collected in New Jersey, in 1886 (1). It was collected later in New Jersey in 1889, in New York in 1890, in the District of Columbia in 1891, 1894, and 1896, in Massachusetts in 1894, and in Chicago, Ill., in 1897 (2, p. 15). In 1903 specimens were sent to the Bureau of Entomology from Cleveland, Ohio, infesting the Meteor variety, with the report that as many as 35 larvæ had been taken from a single bud. Apparently the same insect was received from Cincinnati, Ohio, in 1905, where it was seriously damaging the buds and tips of the La France and Duchess of Albany. Notwithstanding the fact that in the houses containing both varieties the heat was turned off throughout the entire winter, the correspondent reported that the hibernating midge was not killed.

In 1911 a heavy infestation of the variety My Maryland was reported from Rhode Island, and in 1915 Hewitt (5) recorded the occurrence of this midge in a garden at London, Ont., infesting shoots of the variety Mrs. J. Laing. In 1916 Gibson (8) reported it from the same locality and also in greenhouses at Toronto, Ont. Snodgrass (7) includes the rose midge among the important insect pests of Indiana, and Crosby and Leonard (6) state that it attacks roses grown in the open in New York.

Although the rose midge has been reported frequently from several States, it does not necessarily follow that these infestations are still in existence, since some of the varieties subject to infestation have been given up for more resistant and profitable varieties, and in others the insects may have been exterminated by the use of insecticides. Rose houses in the District of Columbia were repeatedly inspected during the past two years, and no infestations were located.

DESCRIPTION.[1]

EGG.

FIG. 1, A.

Egg elongate ovoid, yellowish, about 0.32 mm. long and 0.075 mm. in width.

LARVA.

FIG. 1, C.

Full-grown larva about 1.8 mm. in length, 0.45 mm. in width, reddish in color, obtuse and tuberculated on posterior segment, tubercles bearing minute apical spines, lateral margins distinctly compressed, attenuated anteriorly, breast-bone distinct, with distinct black spot on upper side immediately in front of breast-bone.

PUPA.

FIG. 1, E.

Length of pupa 1.6 mm., width 0.53 mm.; color varying from reddish to reddish yellow, eyes black at time of emerging from cocoon, legs and antennæ approaching black with head and prothorax dusky; all segments except first

[1] The descriptions of the egg, larva, and pupa are compiled from Webster (2, p. 21–23); that of the adults is copied verbatim from Felt (4).

bearing a transverse spinulose ridge on dorsal surface, ventral surface without these ridges; bases of antennæ produced with usual pair of bristles immediately posterior to them and with two large respiratory tubes protruding through cocoon.

ADULT.

Male [Fig. 1, F]. Length 1 mm. Antennæ short, 9 subsessile segments, the fifth with a length only a little greater than its diameter, the last segment greatly produced, with a length about four times its diameter. Palpi; the first

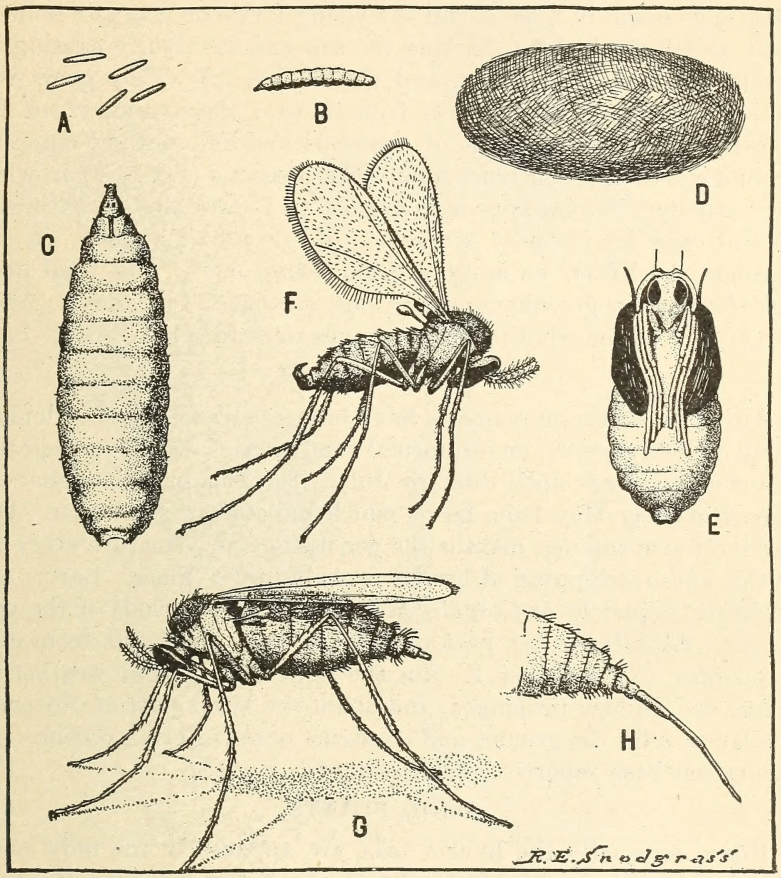

FIG. 1.—The rose midge (*Dasyneura rhodophaga*), enlarged about 27 diameters: *A*, eggs; *B*, young larva; *C*, full-grown larva; *D*, cocoon; *E*, pupa; *F*, adult male; *G*, adult female; *H*, female ovipositor. (9th Ann. Rept. State Ent. Ind.)

segment short, the second broadly oval, the third one-half longer, dilated, the fourth as long as the third, slender. Head and thorax brown, the abdomen, in alcoholic specimens, yellowish. Wings hyaline, costa dark brown, third vein curving forward. Claws long, slender, the pulvilli a little shorter than the claws. Genitalia; basal clasp segment slender; terminal clasp segment long, slightly swollen basally; dorsal plate broad, deeply and narrowly incised, ventral plate long, broadly and roundly emarginate. Harpes long, subtruncate and irregularly tuberculate.

Female [Fig. 1, G]. Length 1 to 1.25 mm. Antennæ short; 9 subsessile segments, the fifth with a length nearly twice its diameter, the terminal segment

greatly produced, with a length about five times its diameter. Ovipositor nearly as long as the abdomen, the terminal lobes narrowly oval, tapering. Other characters presumably as in the opposite sex.

LIFE HISTORY.

The female midge, with her long ovipositor, places small yellowish eggs just under the sepals of the flower buds or between the folded leaves of the leaf buds. Under favorable temperature conditions these eggs hatch in 2 days, and the young larvæ or maggots immediately attack the buds, extracting the sap and eventually causing the petals and leaves to dry up and die. (Fig. 2.) They grow very rapidly, reaching maturity in from 5 to 7 days, and, when full grown, work their way out of the buds and fall on and enter the ground where they construct small silken cocoons (fig. 1, D) in which they pupate. Adults appear in from 5 to 7 days, and shortly after deposit eggs for the next generation of larvæ or maggots. In confinement the life of an adult is from 1 to 2 days. The total cycle, therefore, under greenhouse conditions, is from 12 to 16 days. About 85 per cent of the adults reared in cages were females.

SEASONAL HISTORY.

Although larvæ or maggots have been observed injuring buds as early as February 22, under normal conditions they do not appear in injurious numbers until June or July. In Washington adults were reared in early May from larvæ which pupated in November. During the warm summer months the generations may mature every two weeks, and overlapping of broods probably takes place. Larvæ were especially injurious at Colgate, Md., during two periods of the year, namely, from the latter part of May to early July and from early September to November 1. On the approach of cold weather the stages are slightly prolonged, and about the latter part of November the larvæ enter the ground and construct overwintering cocoons. No injury has been reported during winter.

FOOD PLANTS.

Roses, especially the hybrid teas, are apparently the only plants attacked by this insect. It has been recorded as infesting the Radiance, Hadley, Russell, Killarney, Ophelia, Hoosier Beauty, Shawyer, My Lady, American Beauty, Uncle John, Joe Hill, Kate Moulton, Bridesmaid, Liberty, Richmond, Mrs. John Laing, Meteor, Madam Chatenay, Ivory, Golden Gate, Wooten, La France, and a sport of the latter, the Duchess of Albany.

EXPERIMENTS IN CONTROL.

At the suggestion of Prof. E. N. Cory a series of experiments, in which the following combinations were used as sprays, was conducted to determine the value of molasses in catching the larvæ, thus pre-

venting their entrance to the soil where pupation takes place: (1) Two pounds (by weight) of molasses, 3 gallons of water, 200 cc. of nicotine sulphate (40 per cent nicotine), and $\frac{1}{2}$ ounce (by weight) of lead arsenate; (2) $1\frac{1}{2}$ pounds (by weight) of molasses, 3 gallons of water, 30 cc. of nicotine sulphate (40 per cent nicotine), and $\frac{1}{2}$ ounce (by weight) of fish-oil soap; (3) 2 pounds (by weight) of molasses,

FIG. 2.—Young leaves and flower buds of roses injured by larvæ of the rose midge.

$2\frac{1}{2}$ gallons of water, 25 cc. of nicotine sulphate (40 per cent nicotine), $\frac{4}{5}$ ounce (by weight) of neutral soap, $1\frac{3}{5}$ ounces (by weight) of lead arsenate, and $6\frac{2}{5}$ ounces of Bordeaux mixture; (4) 2 pounds (by weight) of molasses, $2\frac{1}{2}$ gallons of water, 25 cc. of nicotine sulphate (40 per cent nicotine), and $1\frac{3}{5}$ ounces lead arsenate; (5) 2 pounds (by weight) of molasses, $2\frac{1}{2}$ gallons of water, and $1\frac{3}{5}$ ounces (by weight) of lead arsenate; (6) 2 pounds (by weight) of molasses and $2\frac{1}{2}$ gallons of water.

All of the foregoing experiments were conducted in a commercial greenhouse, and each test represents a 50-foot bed of roses. For the most part the killing results of all six experiments were satisfactory. Unfortunately, however, the molasses served as a medium for the development of sooty mold, and, moreover, where lead arsenate was used an objectionable white deposit developed. The presence of either on cut flowers necessarily would reduce their value and in some instances would eliminate them from the market. As the rose midge usually is present at a season when the grower can ill afford to have objectionable deposits on his cut flowers, it is evident that any of the foregoing combinations will be unsatisfactory, unless some method of counteracting these objectionable features is developed. In addition to the foregoing, 1 part of nicotine sulphate (40 per cent nicotine) to 400 parts of water, with the addition of enough soap to produce suds, was tested. The results of this experiment were very unsatisfactory, fully 95 per cent of the larvæ being uninjured.

To determine the value of tobacco dust in preventing the full-grown larvæ, or grubs, from entering the soil, the following cage experiments were conducted: (1) Soil around caged plants covered with dry tobacco dust; (2) same as former except that the dust was wet. Full-grown larvæ which were placed in the cage containing dry dust were active for 24 hours, but did not go below the surface, whereas the larvæ similarly placed in cage 2 were exceedingly active upon coming in contact with the wet dust, acting as if they were burned, and after from 5 to 8 hours they were all dead. All larvæ used in the check immediately entered the soil.

Having determined a satisfactory method of preventing the entrance of the full-grown larvæ into the soil, all of the rose beds in the infested houses at Colgate, Md., were covered on October 12, 1916, with tobacco dust averaging from one-fourth to one-half inch deep. To prevent the larvæ from entering the dirt walks of the houses, all walks were sprayed with 5 per cent kerosene emulsion. Simultaneously nightly fumigation with tobacco stems was inaugurated and continued until October 30, inclusive, and from that date until November 8 the houses were fumigated every other night. The object of this fumigation was to kill all adults before eggs were deposited.

Although this control work was not undertaken until October 12, its effectiveness was soon apparent, and by the latter part of October it was very difficult to locate an infested bud. Not only was the midge under control, but the owner was enabled to bring on his fall crop earlier than was the case in 1915. On May 7, 1917, these houses were carefully examined, and only 6 larvæ were located, 2 in the buds of the Hadley and 4 in the buds of the Radiance. All plants at this time were in excellent condition and gave promise of pro-

ducing a full crop of flowers. These houses were again carefully examined on June 19, and no injury was to be found on any of the plants which had been infested so severely during the fall of 1916. Moreover, the owner reported that up to June 19 more than twice as many blooms had been cut as during the entire previous year.

The rapid elimination of this pest was due no doubt to two causes, (1) nightly fumigation, which killed off the adults before egg-laying took place, and (2) the application of tobacco dust, which prevented the larvæ from entering the soil. Moreover, the tobacco dust served a dual purpose, since it prevented the larvæ from entering hibernating quarters and at the same time fertilized the soil.

METHODS OF CONTROL.

It is evident from the experiment described above that a severe infestation of the rose midge can be controlled, if not entirely eliminated, in a comparatively brief period by the careful application of tobacco dust on the soil and by persistent nightly fumigation with tobacco, in the form of stems, nicotine papers, or one of the volatile nicotine preparations.[1]

Where earth walks are present, it is advisable to spray the walks also with a 5 or 10 per cent kerosene emulsion.[2]

In the case of light infestations, the midge can be controlled by systematic nightly fumigations with tobacco fumes, which should be continued until all adults disappear; or by a careful application, at the proper season, of tobacco dust. Inasmuch as the broods probably overlap during the summer, there is a possibility that frequent syringing of the plants would cause much of the dust to wash down into the soil before all larvæ matured; hence there is a chance that some would fall on and enter earth where the dust had lost its effectiveness. It would seem, therefore, that the most opportune time to apply the dust, if not accompanied with nightly fumigation, is

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[1] Although tobacco stems have been used in greenhouses from time immemorial they are being replaced rapidly by nicotine paper and the volatile nicotine extract, owing to the fact that the nicotine content of the stems is so variable. Tobacco stems in the proper condition (those which have not been allowed to become wet and dry out) will yield good results. As there is no satisfactory and easy method by which the florist can determine accurately the nicotine content of tobacco stems, however, it will probably be a saving of time and money to use the nicotine papers or the volatile nicotine extracts, in which case the directions on the label of the container should be followed.

[2] Kerosene emulsion (stock solution, 66 per cent oil) is made after the following formula:

Kerosene (coal oil, lamp oil)	gallons	2
Soap (fish-oil or laundry) (or 1 quart soft soap)	pound	½
Water (soft)	gallon	1

First dissolve the soap in boiling water, then remove the vessel from the fire and immediately add the kerosene, thoroughly agitating the mixture until a creamy solution results. The stock solution may be more conveniently made by pouring the mixture into the tank of a spray pump and pumping the liquid through the nozzle back into the tank for five minutes. A 10 per cent solution can be made by adding to each gallon of the stock solution about 5⅔ gallons of water. In some regions the water is "hard," and in such cases it should be broken with a little lye, or rain water should be used.

during the latter part of October or the first three weeks of November, at which season the last generation of larvæ leaves the plants, enters the ground, and constructs overwintering cocoons. If dependance is placed on the dust alone, it is imperative that the application be so timed as to be on the soil before the larvæ seek winter quarters. No hard and fast rule governing the date of this application can be recommended for all localities, since temperature naturally influences the final disappearance of the larvæ.

PRECAUTIONARY MEASURES.

The rose midge can be kept out of greenhouses if proper precautions are exercised. Under no condition should infested plants be taken into a house free from this pest. Plants should not be purchased knowingly from firms which carry infested stock, and should be bought with the understanding that they are free from the midge either in the buds or in the soil. Before new stock is placed in a house, all plants should be examined carefully, and suspicious ones destroyed or returned to the shipper.

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